

# Robert Miner Dynamic Testing, Inc.

Dynamic Measurements and Analyses for Deep Foundations

June 16, 2021

Ilima Alexander  
Flatiron-Lane JV  
1400 Talbot Rd S. Ste. 500  
Renton, WA 98055

Re: Wave Equation Analysis of Pile Driving  
Southbound Piers 1 and 2: PP30"x0.625", Open-ended  
APE D50-42 and Pileco D62-22 Open-end Diesel Hammer  
WSDOT I-405 Renton to Bellevue Design-Build: May Creek Bridge  
Renton, Washington

I-405, Renton to Bellevue Widening & Express Toll Lanes Project

DOCUMENT REVIEW	
<input type="checkbox"/> APPROVED, NO EXCEPTION TAKEN	<input checked="" type="checkbox"/> APPROVED AS NOTED
<input type="checkbox"/> RESUBMIT, REVISE AS NOTED	<input type="checkbox"/> REVIEWED COMMENTS PROVIDED IF ANY
REVIEWED BY: JDW	DATE: 7/16/21
BL	

Review is for general conformance with contract or design requirements. Sole responsibility for correctness of dimensions, details, quantities, materials, and safety during fabrication and erection shall remain with the contractor

RMDT Job No. 21F17

Ms. Alexander:

At your request, we performed wave equation analyses for the project referenced above. The objectives of these analyses were prediction of axial pile stresses and penetration resistances during pile driving for application to evaluation of hammer suitability. The following sections summarize data submitted to Robert Miner Dynamic Testing, Inc. (RMDT), program input, analyses made, results, and our opinions regarding certain aspects of pile driveability.

## ANALYSIS DETAILS

Our analyses are primarily based on project documents you provided. These documents included Section 6-05 of the amended project specifications, Plan Sheets BG25E1-E9 and BG25W1-W9, a Geotechnical Engineering Report (July 06, 2020) prepared by Wood Environment & Infrastructure Solutions, Inc. and the pile driving equipment data forms. Additional information incorporated into our analyses and discussion was taken from GRLWEAP™ program data files, or based on our judgment.

**Program:** GRLWEAP™, Version 2010

**Pile Details:** The proposed piles are vertical 30" OD open-ended steel pipe piles with a wall thickness of 0.625" and final driven lengths ranging from 61 to 62 ft. We understand that all steel pile material conforms to ASTM A252 Gr 3 specification with a modified minimum yield strength, Fy, of 50 ksi.

### Soil and

### Foundation

**Design:** Subsurface conditions at the site are reported to consist of 20 to 30 ft of recently deposited loose to medium dense primarily granular material underlain by glacially overridden dense to very dense sands and gravels. The foundation design anticipates all piles will achieve end bearing in the lower dense glacially overridden material.

JDW: Okay - A709 shown in RAM

Information contained on Plan Sheet BG25W6 indicate all piles associated with the Southbound Bridge are to be driven vertically to a minimum elevation of +23 ft at Pier 1 and +20 ft at Pier 2. Test Piles in Pier 1 and 2 are required to achieve a nominal driving resistance of 838 and 787 kips, respectively. However, during production driving, piles in Piers 1 and 2 are required to achieve a minimum nominal driving resistance of 782 and 723 kips, respectively. Select pile design details provided on Plan sheet BG25W6-W8 are summarized in Table 1. For further information on the soils and foundation design please refer to appropriate project documents.

Table 1: Selected Details for PP30"x0.625" Southbound Pier Piles						
Structure	Minimum Tip Elevation (ft)	Estimated Tip Elevation (ft)	Bottom of Pile Cap Elevation (ft)	Estimated Pile Tip Depth (ft)	Minimum Bearing Capacity <sup>1</sup> (kips)	Required Driving Resistance <sup>2</sup> (kips)
SB Pier 1	23.0	14.0	62.0	48.0	782	838
SB Pier 2	20.0	6.5	55.5	49.0	723	787
Note <sup>1</sup> : Apparent nominal driving resistance for production piles						
Note <sup>2</sup> : Apparent nominal driving resistance for Test Piles during PDA testing						

**Hammers:** At your request we considered both the APE D50-42 and Pileco D62-22 single-acting diesel hammers. Driving system parameter values used in our analyses are summarized in Table 2.

Table 2: Select Driving System Details					
Hammer	Maximum Rated Energy kip-ft	Ram Weight kips	Maximum Ram Stroke ft	Helmet Weight kips	Hammer Cushion Stiffness kip/inch
APE D50-42	124	11.0	11.3	5.47	39,981
PileCo D62-22	161	13.7	11.8	5.47	55,729

### Analysis

**Input:** Wave equation analyses were completed for a 30" OD pile driven open-ended with an APE D50-42 and a PileCo D62-22 hammer models. Analyses were completed for a 62 ft pile installed through granular material (triangular distribution) to a depth of 49 ft. We modeled the distribution of the ultimate resistance as predominately a result of end bearing. The soil parameters and related information which we used in our wave equation analyses are summarized in Table 3.

Table 3: Select GRLWEAP Analysis Inputs	
Pile Length	62 ft
Soil Penetration	49 ft
Soil Quake (skin)	0.10 in
Soil Quake (toe)	0.25 in
Soil Damping (skin)	0.10 sec/ft
Soil Damping (toe)	0.15 sec/ft
% Shaft Friction	40% (Triangular Resistance Distribution)

RMDT did not perform soil resistance calculations to compute any relation between soil resistance and length of pile penetration. Such static soil analyses were beyond the scope of this report. Total soil resistance primarily controls wave equation results with respect to driveability; reasonable variations in assumed total soil penetration or resistance distribution typically has only minor effects on these computed results.

### ***Hammer Approval***

#### ***Requirements:***

The analyses presented here follow certain requirements of the 2018 Washington State Standard Specifications (6-05.3(9)A) under which the predicted penetration resistance must be less than 100 blows per ft for the required ultimate (nominal) resistance and the predicted pile stresses must be less than 90 percent of yield.

#### ***Analysis***

##### **Type:**

We completed Bearing Graph format analyses with a range of soil resistance values and the two hammer efficiencies, 0.72 and 0.84 percent called for in the Washington State Standard Specifications (6-05.3(9)A). Results for analyses with the lower and higher efficiencies are identified by "LO" and "HI" in the analysis title block. For each assigned axial soil resistance the GRLWEAP Bearing Graph results included predicted peak axial compressive stresses and penetration resistance (blows per ft).

For all analyses the hammer peak combustion pressure was set to equal 100-percent of the GRLWEAP default value. A combustion pressure of 100-percent may be taken to reflect hammer operation at the maximum fuel setting.

## GRLWEAP RESULTS

The GRLWEAP Bearing Graph Analyses provide values for penetration resistance (blows per ft) and driving stress for a wide range of assigned soil resistance values. Attached pages contain a graphical summary of results and a summary of key program inputs in our analyses. Additional pages provide numerical summaries of the analyses. Appendix A contains further input and results which may be used for more detailed review of the analyses we completed.

## DISCUSSION

The following results and opinions are based on the information provided to us, the results of our analyses, and our engineering judgement.

### APE D50-42

1. GRLWEAP analyses with a hammer efficiency of 0.72 (LO) yielded a penetration resistance of approximately 59 BPF for a resistance of 838 kips (SB Pier 1) and 52 BPF for a driving resistance of 787 kips (SB Pier 2). The calculated ram stroke height corresponding to resistance values of 838 and 787 kips is 8.8 and 8.6 ft, respectively. In our opinion, hard driving should be expected with the APE D50-42 if driving resistances of 1040 kips or greater are encountered prior to reaching the minimum pile tip elevation.
  
2. GRLWEAP analyses with a hammer efficiency of 0.84 (HI) yielded a maximum computed axial compressive driving stress below 31 ksi for the largest analyzed resistance of 1400 kips. The calculated ram stroke height corresponding to a resistance value of 1400 kips is 9.7 ft. The computed stress values are within the commonly acceptable stress limits for ASTM A252 GR 3 material.

### PileCo D62-22

3. GRLWEAP analyses with a hammer efficiency of 0.72 (LO) yielded a penetration resistance of approximately 44 BPF for a resistance of 838 kips (SB Pier 1) and 40 BPF for a driving resistance of 787 kips (SB Pier 2). The calculated ram stroke height corresponding to a resistance value of 838 and 787 kips is 9.6 and 9.5 ft, respectively. In our opinion, hard driving should be expected with the PileCo D62-22 if driving resistances of 1200 kips or greater are encountered prior to reaching the minimum pile tip elevation.
  
4. GRLWEAP analyses with a hammer efficiency of 0.84 (HI) yielded a maximum computed axial compressive driving stress below 41 ksi for the largest analyzed resistance of 1600 kips. The calculated ram stroke height corresponding to a resistance value of 1600 kips is 11.1 ft. The computed stress values are within the commonly acceptable stress limits for ASTM A252 GR 3 material.

APE D50-42 and PileCo D62-22

5. It is our opinion that either the APE D50-42 or the PileCo D62-22 are suitable hammers to achieve project goals. Both hammers are expected to accommodate a modest degree of overdriving relative to the required and anticipated soil resistances at the Southbound Bridge location.
6. The GRLWEAP computed driving stresses do not include any stresses that result from local contact or bending. Thus, total stresses may be higher than the GRLWEAP computed values. We recommend careful attention to preparation of the pile for driving and proper alignment of the hammer, helmet, striker plate, and pile during all driving.
7. The APE D50-42 and PileCo D62-22 hammers have a variable fuel supply that provides some control of the ram stroke height. Although the calculated axial stresses for strokes of approximately 10 to 11 ft are within project guidelines for both the hammers, we recommend that either hammer be operated in such a manner so as to keep the ram stroke below 9.5 ft. Within this recommended stroke limit, each hammer is expected to be capable of overcoming soil resistances greater than the project's highest required resistance of 838 kips. Relative to the PileCo D62-22 hammer, the APE D50-42 hammer is expected to install piles with lower axial driving stresses.
8. We understand that dynamic pile testing with a Pile Driving Analyzer® and CAPWAP® signal matching will occur during test pile installation. The results of such testing and CAPWAP analysis may be used to evaluate the soil resistance at the time of testing. The GRLWEAP analyses presented and discussed herein are primarily intended to address hammer selection and should not be used for pile inspection or pile acceptance activities without review or modification based on field observations and field data, including the results of the PDA monitoring and CAPWAP analyses.

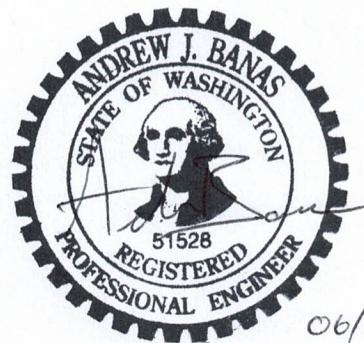
**ADDITIONAL CONSIDERATIONS**

Please note that the results calculated by the wave equation analysis program depend on a variety of hammer, pile and soil input parameters. Please also review the information that is given on the cover page for Appendix A. We attempted to base our analyses on our best interpretation of information provided to us for this work and to also consider the relation of uncertainty to our opinion about hammer suitability. However, actual field conditions, project requirements and hammer performance may vary from what we assumed and therefore driving stresses and blow counts may differ from these predictions. Soil setup during interruptions to driving, or soil conditions that cause actual resistance values to exceed the stated resistance values may cause harder driving than is predicted in these analyses. RMDT did not evaluate or predict any relation between tip elevation and soil resistance or tip elevation and driving resistance. Soil resistance values assigned in wave equation analyses are ultimate resistance values.

We enjoyed performing these analyses for you. If you or your client have any questions or if we can provide further assistance, please contact us.

Sincerely,

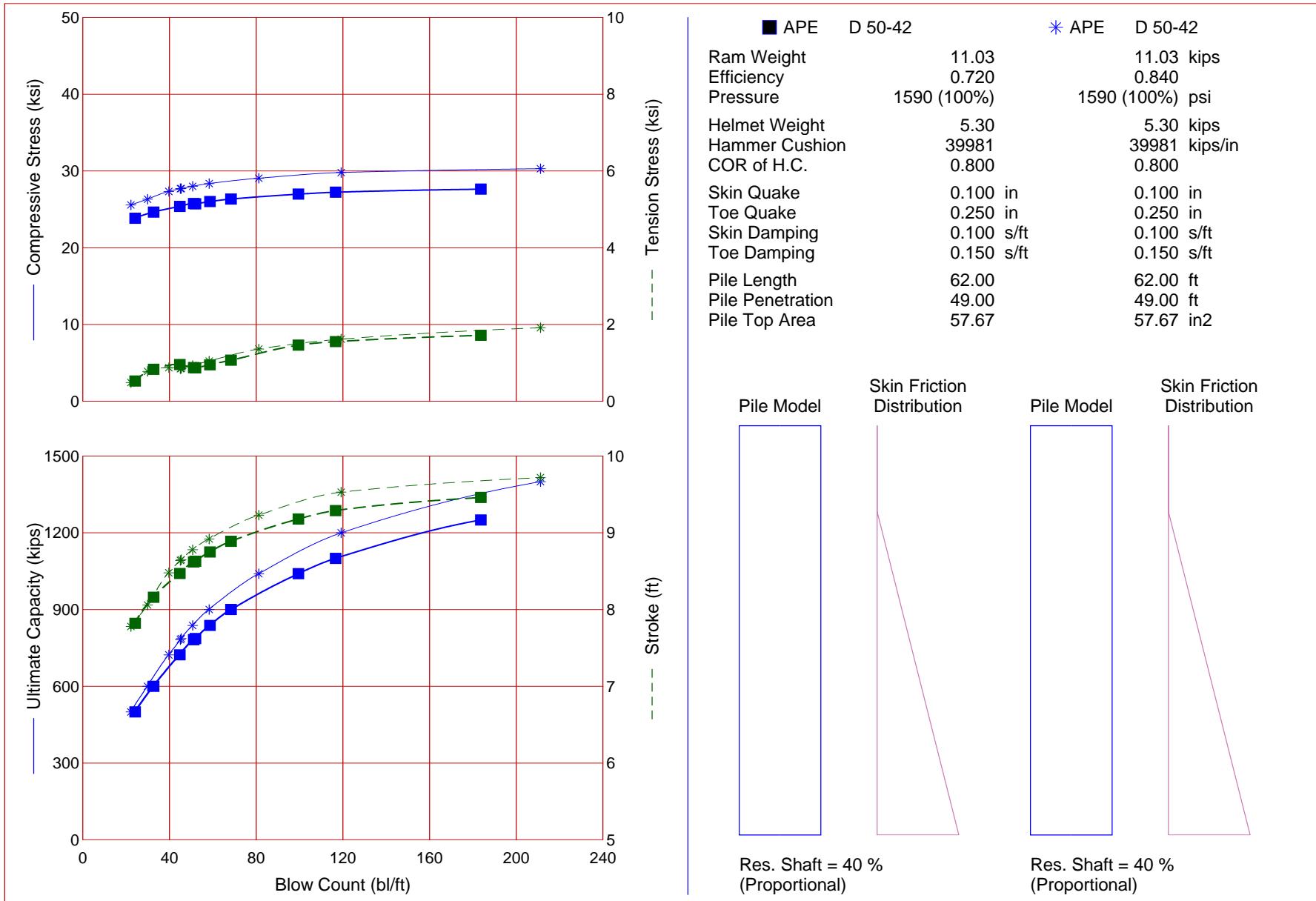
Andrew J. Banas, P.E.



06/16/2021

Robert Miner Dynamic Testing, Inc.

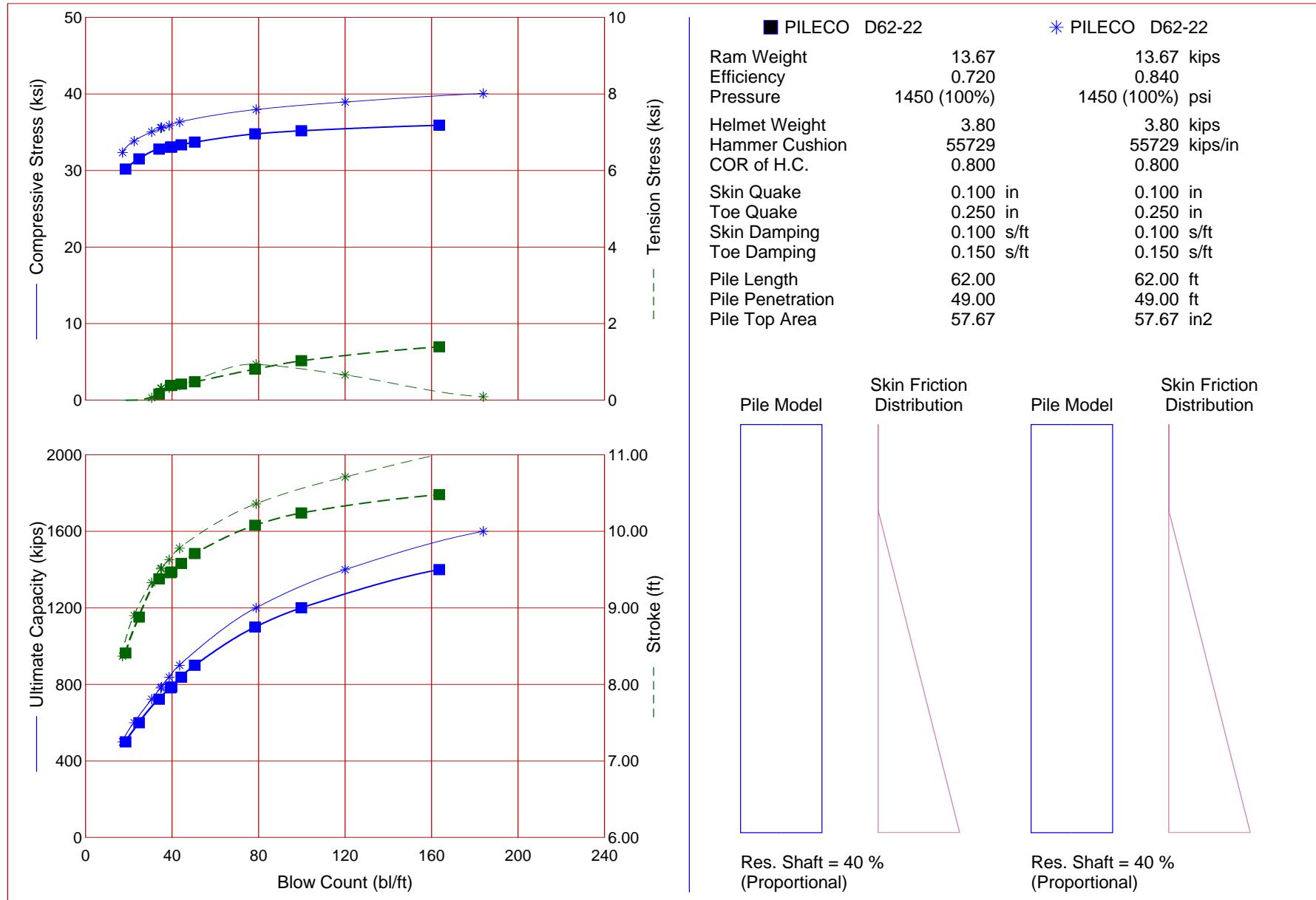
■ Flatiron,SBMayCrk,PP30"x0.625",APED50,LO  
 \* Flatiron,SBMayCrk,PP30"x0.625",APED50,HI



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	23.84	0.53	24.2	7.82	49.49
600.0	24.64	0.83	32.7	8.16	49.07
723.0	25.38	0.96	44.8	8.47	48.72
782.0	25.75	0.88	51.2	8.62	48.97
787.0	25.73	0.87	52.0	8.63	48.91
838.0	26.01	0.95	58.7	8.75	49.53
900.0	26.34	1.07	68.4	8.89	50.24
1040.0	26.98	1.46	99.5	9.18	51.49
1100.0	27.23	1.55	116.7	9.29	51.96
1250.0	27.63	1.72	183.7	9.46	52.37

Flatiron,SBMayCrk,PP30"x0.625",APED50,HI

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	25.58	0.49	22.2	7.78	54.83
600.0	26.32	0.78	29.9	8.06	54.13
723.0	27.33	0.88	39.7	8.48	54.58
782.0	27.69	0.85	45.0	8.64	54.81
787.0	27.71	0.86	45.4	8.65	54.93
838.0	28.01	0.93	50.7	8.78	55.60
900.0	28.36	1.05	58.3	8.92	56.40
1040.0	29.06	1.36	81.2	9.23	58.03
1200.0	29.80	1.62	119.2	9.53	59.53
1400.0	30.30	1.92	211.2	9.72	60.03



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	30.19	0.00	18.5	8.41	64.21
600.0	31.51	0.00	24.8	8.88	63.80
723.0	32.79	0.16	34.0	9.38	64.32
782.0	33.03	0.38	39.4	9.46	63.55
787.0	33.07	0.39	39.8	9.47	63.53
838.0	33.35	0.42	44.3	9.58	63.59
900.0	33.70	0.48	50.5	9.71	64.26
1100.0	34.78	0.81	78.4	10.08	66.34
1200.0	35.19	1.03	99.8	10.24	67.04
1400.0	35.90	1.39	163.6	10.48	67.96

Flatiron,SB MayCrk,PP30"x0.625",PCD62,HI

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	32.34	0.00	17.1	8.37	71.57
600.0	33.84	0.00	22.5	8.90	71.92
723.0	35.06	0.06	30.6	9.33	71.88
782.0	35.55	0.31	34.8	9.51	72.03
787.0	35.63	0.31	35.1	9.52	72.10
838.0	35.86	0.33	38.7	9.63	72.01
900.0	36.33	0.39	43.5	9.78	73.11
1200.0	37.96	0.94	78.9	10.36	76.68
1400.0	38.95	0.66	120.0	10.71	78.71
1600.0	40.05	0.09	183.9	11.11	81.30

## **Appendix A**

### **INFORMATION ON USE OF GRLWEAP RESULTS AND GRLWEAP PROGRAM OUTPUT**

The GRLWEAP wave equation program uses mathematical models that describe motions and forces within hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate complex, dynamic behavior. Input parameter values are partially or completely intended to model normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. Thus, in some cases the data supplied with the program and data selected by RMDT may reflect conditions that differ significantly from actual field conditions. The GRLWEAP program authors and RMDT recommend prudent and informed use of the GRLWEAP results. Generally, aspects of the soil response and hammer performance should be verified by dynamic measurements and CAPWAP analyses, static load testing, or other suitable methods of analysis and inspection.

Driving stresses computed by the GRLWEAP program do not include bending or other local non-axial stresses, prestresses or residual fabrication stresses. Thus, inspection based on GRLWEAP results must account for those and any other sources of additional stress.

All GRLWEAP results, including those from Bearing Graph or Inspector's Graph analyses should be used in conjunction with observed blow counts and observed strokes. However, time dependent soil strength changes, such as "setup" or "relaxation" may alter the soil resistance and produce long term ultimate bearing capacity values that differ substantially from those expected based on observed blow counts and wave equation analysis. Also, hammer strokes, transfer energy and soil resistance may vary over the interval that the blows are counted, especially for restrikes or piles driven to rock. Inspection procedures should account for these sources of variation or uncertainty.

The GRLWEAP soil resistance values are ultimate values for compressive (downward) pile loads. They MUST be reduced by an appropriate factor to yield a design or working load or factored resistance. If a factor is not specified in project documents selection or statement of an applicable factor of safety or a resistance factor should involve the foundation engineer or the engineer directing pile acceptance. RMDT recommends that the factor of safety or resistance factor reflect the quality of construction control, the variability of the site conditions, uncertainties in the loads, the nature of the structure, applicable codes, and other relevant factors.

Input File: G:\SHARED DRIVES\PJ\FLATIRON, MAY CREEK\FLATIRON,SB MAY CRK,PP30X0.625,APE D50, HI.GWW  
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW  
 Hammer File Version: 2003 (12/4/2018)

Input File Contents

Flatiron,SBMayCrk,PP30"x0.625",APED50,HI

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEX
6	0	583	0	1	0	0	0	0	0	40	0	0	0	0	0	0	0	0.000
Pile g Hammer g Toe Area Pile Size									Pile Type									
32.170		32.170		57.670		30.000												Pipe
W Cp		A Cp		E Cp		T Cp		CoR		ROut		StCp						
5.300		491.000		285.0		3.500		0.800		0.010		0.0						
A Cu		E Cu		T Cu		CoR		ROut		StCu								
0.000		0.0		0.000		0.000		0.000		0.0								
LPle		APle		EPle		WPle		Peri		CI		CoR		ROut				
62.000		57.67		30000.0		492.000		7.854		0		0.850		0.010				
FFatigue		F0		0-Bottom														
0		0.000		0.000														
Manufac	Hmr	Name	HmrType	No	Seg-s													
APE	D	50-42		1		5												
Ram Wt		Ram L		Ram Dia		MaxStrk		RtdStrk		Efficcy								
11.02		148.00		19.66		13.08		11.25		0.80								
IB. Wt		IB. L		IB.Dia		IB CoR		IB RO										
2.27		33.30		19.66		0.900		0.010										
CompStrk	A	Chamber	V	Chamber		C Delay		C Duratn		Exp		Coeff		VolCStart		Vol	CEnd	
18.94		304.30		458.90		0.0010		0.0020		1.250		0.00		0.00				
P atm		P1		P2		P3		P4		P5								
14.70		1590.00		1430.00		1290.00		1160.00		0.00								
Stroke		Effic.	Pressure	R-Weight		T-Delay		Exp-Coeff		Eps-Str		Total-AW						
11.2500		0.8400		1590.0000		0.0000		0.0000		0.0000		0.0100		0.0000				
Qs		Qt		Js		Jt		Qx		Jx		Rati		Dept				
0.100		0.250		0.100		0.150		0.000		0.000		0.000		0.000				
Research	Soil	Model:	Atoe,	Plug,	Gap,	Q-fac												
0.000		0.000		0.000		0.000												
Research	Soil	Model:	RD-skn:	m,	d,	toe: m,	d											
0.000		0.000		0.000		0.000												
Research	Toe	Plug:	Res-int,	Q-int,	D-int,	Res-plug,	Q-plug,	D-plug										
0.000		0.000		0.000		0.000		0.000		0.000								
Research	Toe	Plug:	RD	plug	toe: m,	d												
0.000		0.000																
Research	Toe	Plug:	New	Toe	Plug	Model	is NOT applied											
Res.	Distribution																	
Dpth	Rskn		Dpth	Dpth														
0.00	0.00		49.00	49.00		0.00		0.00		0.00		0.00		0.00		0.000		
49.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.000		
62.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.000		
Rult																		
500.0	600.0		723.0	782.0		787.0		838.0		900.0		1040.0		1200.0		1400.0		

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS  
 Version 2010  
 English Units

Flatiron, SBMayCrk, PP30"x0.625", APED50, HI

Hammer Model:		D 50-42	Made by:	APE	
No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.205				
2	2.205	297415.3	1.000	0.0000	
3	2.205	297415.3	1.000	0.0000	
4	2.205	297415.3	1.000	0.0000	
5	2.205	297415.3	1.000	0.0000	
Imp Block	2.270	139960.1	0.900	0.0100	
Helmet	5.300	39981.4	0.800	0.0100	13.6
Combined Pile Top		44182.6			

HAMMER OPTIONS:

Hammer File ID No.	583	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	11.02	Ram Length	(inch)	148.00
Maximum Stroke	(ft)	13.08			
Rated Stroke	(ft)	11.25	Efficiency		0.840
Maximum Pressure	(psi)	1590.00	Actual Pressure	(psi)	1590.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	19.66			
Combustion Delay	(s)	0.00100	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in <sup>2</sup> )	491.00	Cross Sect. Area	(in <sup>2</sup> )	0.00
Elastic-Modulus	(ksi)	285.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	3.50	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	39981.4	Stiffness	(kips/in)	0.0

**PILE PROFILE:**

Toe Area	(in2)	57.670	Pile Type	Pipe
Pile Size	(inch)	30.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	57.67	30000.	492.0	7.9	0	16807.	102.9
62.0	57.67	30000.	492.0	7.9	0	16807.	102.9

Wave Travel Time 2L/c (ms) 7.378

No.	Weight	Pile and Soil Model				Soil-S	Soil-D	Quake	Total Capacity (kips)	Rut (in)	500.0
		Stiffn	C-Slk	T-Slk	CoR						
		kips	k/in	ft	ft	ft	ft	ft	ft	ft	in2
1	0.643	44183	0.010	0.000	0.85	0.0	0.100	0.100	3.26	7.9	57.7
2	0.643	44183	0.000	0.000	1.00	0.0	0.100	0.100	6.53	7.9	57.7
5	0.643	44183	0.000	0.000	1.00	0.9	0.100	0.100	16.32	7.9	57.7
6	0.643	44183	0.000	0.000	1.00	2.7	0.100	0.100	19.58	7.9	57.7
7	0.643	44183	0.000	0.000	1.00	4.5	0.100	0.100	22.84	7.9	57.7
8	0.643	44183	0.000	0.000	1.00	6.2	0.100	0.100	26.11	7.9	57.7
9	0.643	44183	0.000	0.000	1.00	8.0	0.100	0.100	29.37	7.9	57.7
10	0.643	44183	0.000	0.000	1.00	9.8	0.100	0.100	32.63	7.9	57.7
11	0.643	44183	0.000	0.000	1.00	11.6	0.100	0.100	35.89	7.9	57.7
12	0.643	44183	0.000	0.000	1.00	13.3	0.100	0.100	39.16	7.9	57.7
13	0.643	44183	0.000	0.000	1.00	15.1	0.100	0.100	42.42	7.9	57.7
14	0.643	44183	0.000	0.000	1.00	16.9	0.100	0.100	45.68	7.9	57.7
15	0.643	44183	0.000	0.000	1.00	18.7	0.100	0.100	48.95	7.9	57.7
16	0.643	44183	0.000	0.000	1.00	20.4	0.100	0.100	52.21	7.9	57.7
17	0.643	44183	0.000	0.000	1.00	22.2	0.100	0.100	55.47	7.9	57.7
18	0.643	44183	0.000	0.000	1.00	24.0	0.100	0.100	58.74	7.9	57.7
19	0.643	44183	0.000	0.000	1.00	25.8	0.100	0.100	62.00	7.9	57.7
Toe						300.0	0.150	0.250			

12.216 kips total unreduced pile weight (g= 32.17 ft/s<sup>2</sup>)  
 12.216 kips total reduced pile weight (g= 32.17 ft/s<sup>2</sup>)

**PILE, SOIL, ANALYSIS OPTIONS:**

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	49.00	Pile Damping Fact. (k/ft/s)	2.059
% Shaft Resistance	40		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170	32.170
Output Segment Generation:	Automatic		

No	Rut= 500.0, Rtoe = 300.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1441.9	0.00	25.00	13.39	0.889	54.83
2	-6.7	1446.1	-0.12	25.08	13.40	0.880	54.70
3	-14.0	1452.9	-0.24	25.19	13.43	0.871	54.56
4	-20.1	1459.9	-0.35	25.31	13.44	0.861	54.40
5	-24.7	1465.5	-0.43	25.41	13.42	0.850	54.18
6	-28.2	1471.3	-0.49	25.51	13.39	0.839	53.79
7	-28.2	1475.1	-0.49	25.58	13.36	0.828	53.17
8	-25.8	1473.3	-0.45	25.55	13.28	0.816	52.35
9	-21.9	1470.8	-0.38	25.50	13.20	0.806	51.41
10	-18.8	1465.4	-0.33	25.41	13.11	0.798	50.36
11	-13.7	1454.4	-0.24	25.22	12.98	0.789	49.14
12	-6.2	1444.0	-0.11	25.04	12.84	0.782	47.74
13	0.0	1429.7	0.00	24.79	12.71	0.774	46.18
14	0.0	1409.6	0.00	24.44	12.55	0.766	44.44
15	0.0	1386.4	0.00	24.04	12.49	0.758	42.54
16	0.0	1338.0	0.00	23.20	12.93	0.751	40.45
17	0.0	1227.1	0.00	21.28	14.79	0.744	38.18
18	0.0	1012.1	0.00	17.55	16.28	0.737	35.72
19	0.0	773.9	0.00	13.42	16.28	0.729	34.40

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 7.59 7.78 7.76

Max. Combustion Pressure 1590.0 psi

No	Rut= 600.0, Rtoe= 360.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1481.6	0.00	25.69	13.74	0.794	54.13
2	-9.9	1486.2	-0.17	25.77	13.75	0.782	53.91
3	-19.8	1493.9	-0.34	25.90	13.79	0.771	53.68
4	-29.1	1501.2	-0.50	26.03	13.80	0.759	53.45
5	-37.6	1507.4	-0.65	26.14	13.76	0.747	53.16
6	-43.0	1514.3	-0.75	26.26	13.73	0.736	52.71
7	-44.0	1518.1	-0.76	26.32	13.68	0.723	52.04
8	-42.0	1515.4	-0.73	26.28	13.58	0.711	51.15
9	-44.9	1512.8	-0.78	26.23	13.48	0.698	50.06
10	-43.3	1505.6	-0.75	26.11	13.37	0.685	48.76
11	-36.9	1492.0	-0.64	25.87	13.20	0.671	47.27
12	-26.0	1480.4	-0.45	25.67	13.03	0.658	45.61
13	-10.8	1462.5	-0.19	25.36	12.86	0.648	43.93
14	0.0	1439.6	0.00	24.96	12.65	0.638	42.09
15	0.0	1413.2	0.00	24.50	12.54	0.628	40.08
16	0.0	1360.6	0.00	23.59	12.91	0.618	37.93
17	0.0	1243.6	0.00	21.56	14.57	0.609	35.62
18	0.0	1029.1	0.00	17.85	15.81	0.600	33.16
19	0.0	872.1	0.00	15.12	15.53	0.591	31.82

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.06 8.13

Max. Combustion Pressure 1590.0 psi

No	Rut=	723.0,	Rtoe =	433.8	kips, Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1536.5	0.00	26.64	14.25	0.729	54.58
2	-10.7	1542.2	-0.19	26.74	14.26	0.714	54.22
3	-23.2	1548.3	-0.40	26.85	14.28	0.700	53.84
4	-32.6	1557.3	-0.57	27.00	14.30	0.685	53.46
5	-39.5	1565.5	-0.69	27.15	14.28	0.672	52.99
6	-45.2	1571.2	-0.78	27.24	14.21	0.658	52.35
7	-49.8	1576.2	-0.86	27.33	14.15	0.644	51.48
8	-50.6	1574.0	-0.88	27.29	14.04	0.630	50.44
9	-46.3	1568.3	-0.80	27.20	13.89	0.616	49.22
10	-37.1	1560.3	-0.64	27.05	13.75	0.603	47.80
11	-27.8	1544.9	-0.48	26.79	13.56	0.589	46.21
12	-16.4	1528.8	-0.28	26.51	13.32	0.575	44.44
13	-2.9	1508.0	-0.05	26.15	13.11	0.562	42.52
14	0.0	1480.2	0.00	25.67	12.86	0.549	40.47
15	0.0	1449.0	0.00	25.12	12.66	0.536	38.29
16	0.0	1390.9	0.00	24.12	12.96	0.524	36.00
17	0.0	1269.3	0.00	22.01	14.40	0.513	33.57
18	0.0	1052.3	0.00	18.25	15.41	0.502	31.03
19	0.0	972.9	0.00	16.87	14.82	0.492	29.64

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.48 8.48

Max. Combustion Pressure 1590.0 psi

No	Rut=	782.0,	Rtoe=	469.2	kips, Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1555.3	0.00	26.97	14.42	0.712	54.81
2	-9.3	1560.6	-0.16	27.06	14.43	0.702	54.64
3	-18.5	1569.4	-0.32	27.21	14.47	0.689	54.36
4	-27.5	1577.7	-0.48	27.36	14.48	0.674	53.96
5	-36.4	1584.9	-0.63	27.48	14.44	0.659	53.45
6	-43.8	1593.5	-0.76	27.63	14.39	0.643	52.75
7	-48.0	1597.1	-0.83	27.69	14.32	0.627	51.79
8	-49.0	1592.9	-0.85	27.62	14.18	0.611	50.61
9	-46.5	1589.5	-0.81	27.56	14.04	0.595	49.23
10	-40.7	1578.8	-0.71	27.38	13.87	0.580	47.67
11	-31.6	1562.7	-0.55	27.10	13.65	0.565	45.93
12	-19.3	1545.7	-0.33	26.80	13.42	0.549	44.03
13	-3.6	1521.5	-0.06	26.38	13.17	0.535	41.99
14	0.0	1494.0	0.00	25.91	12.88	0.520	39.81
15	0.0	1459.9	0.00	25.31	12.67	0.506	37.53
16	0.0	1399.5	0.00	24.27	12.92	0.493	35.14
17	0.0	1273.2	0.00	22.08	14.27	0.480	32.64
18	0.0	1059.5	0.00	18.37	15.15	0.468	30.05
19	0.0	1007.4	0.00	17.47	14.45	0.457	28.62

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.64 8.62

Max. Combustion Pressure 1590.0 psi

No	Rut=	787.0,	Rtoe =	472.2	kips, Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1558.1	0.00	27.02	14.45	0.711	54.93
2	-9.4	1565.2	-0.16	27.14	14.48	0.702	54.77
3	-18.7	1572.5	-0.32	27.27	14.50	0.689	54.49
4	-27.8	1578.0	-0.48	27.36	14.48	0.674	54.09
5	-36.8	1588.8	-0.64	27.55	14.48	0.658	53.56
6	-44.1	1596.6	-0.77	27.68	14.42	0.642	52.85
7	-48.4	1597.2	-0.84	27.70	14.31	0.626	51.88
8	-49.4	1598.2	-0.86	27.71	14.21	0.610	50.69
9	-47.0	1591.4	-0.81	27.60	14.07	0.594	49.30
10	-41.1	1580.2	-0.71	27.40	13.87	0.578	47.72
11	-32.0	1566.9	-0.55	27.17	13.67	0.563	45.97
12	-19.5	1546.3	-0.34	26.81	13.45	0.548	44.05
13	-3.7	1523.9	-0.06	26.42	13.17	0.533	41.99
14	0.0	1496.9	0.00	25.96	12.89	0.518	39.81
15	0.0	1460.0	0.00	25.32	12.68	0.504	37.51
16	0.0	1399.6	0.00	24.27	12.91	0.490	35.11
17	0.0	1275.8	0.00	22.12	14.27	0.478	32.60
18	0.0	1060.7	0.00	18.39	15.12	0.466	30.00
19	0.0	1009.5	0.00	17.50	14.39	0.454	28.57

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.65 8.62

Max. Combustion Pressure 1590.0 psi

No	Rut=	838.0,	Rtoe=	502.8	kips, Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1572.7	0.00	27.27	14.58	0.706	55.60
2	-10.1	1580.2	-0.17	27.40	14.61	0.695	55.43
3	-20.2	1588.6	-0.35	27.55	14.64	0.682	55.11
4	-30.3	1595.6	-0.52	27.67	14.64	0.666	54.66
5	-40.2	1604.0	-0.70	27.81	14.60	0.649	54.03
6	-48.3	1613.6	-0.84	27.98	14.56	0.631	53.18
7	-52.8	1615.2	-0.92	28.01	14.46	0.613	52.09
8	-53.8	1613.8	-0.93	27.98	14.32	0.595	50.75
9	-51.2	1608.0	-0.89	27.88	14.18	0.578	49.22
10	-45.0	1594.2	-0.78	27.64	13.98	0.561	47.51
11	-35.3	1580.5	-0.61	27.41	13.73	0.544	45.63
12	-22.0	1560.1	-0.38	27.05	13.50	0.527	43.59
13	-5.0	1533.7	-0.09	26.59	13.22	0.511	41.42
14	0.0	1506.3	0.00	26.12	12.89	0.495	39.14
15	0.0	1468.4	0.00	25.46	12.68	0.480	36.75
16	0.0	1405.8	0.00	24.38	12.87	0.466	34.27
17	0.0	1277.8	0.00	22.16	14.14	0.452	31.70
18	0.0	1064.9	0.00	18.47	14.92	0.439	29.06
19	0.0	1033.3	0.00	17.92	14.12	0.427	27.60

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.78 8.74

Max. Combustion Pressure 1590.0 psi

No	Rut= 900.0, Rtoe = 540.0	kips, Time Inc. = 0.087 ms					
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1590.5	0.00	27.58	14.75	0.700	56.40
2	-11.6	1598.3	-0.20	27.71	14.78	0.689	56.20
3	-22.8	1607.2	-0.40	27.87	14.81	0.675	55.85
4	-33.8	1615.0	-0.59	28.00	14.81	0.658	55.35
5	-44.7	1622.8	-0.77	28.14	14.76	0.640	54.65
6	-53.6	1633.2	-0.93	28.32	14.72	0.620	53.64
7	-58.9	1635.3	-1.02	28.36	14.62	0.600	52.36
8	-60.4	1632.6	-1.05	28.31	14.45	0.580	50.86
9	-57.9	1626.7	-1.00	28.21	14.30	0.561	49.14
10	-51.5	1612.4	-0.89	27.96	14.09	0.542	47.25
11	-41.2	1596.6	-0.71	27.68	13.82	0.523	45.20
12	-27.1	1574.9	-0.47	27.31	13.57	0.505	43.01
13	-9.2	1546.0	-0.16	26.81	13.26	0.488	40.70
14	0.0	1516.8	0.00	26.30	12.92	0.470	38.29
15	0.0	1476.7	0.00	25.61	12.66	0.454	35.79
16	0.0	1411.5	0.00	24.48	12.82	0.438	33.22
17	0.0	1280.7	0.00	22.21	14.00	0.423	30.57
18	0.0	1068.9	0.00	18.54	14.65	0.409	27.88
19	0.0	1058.8	0.00	18.36	13.76	0.396	26.39

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 8.92 8.87

Max. Combustion Pressure 1590.0 psi

No	Rut= 1040.0, Rtoe= 624.0	kips, Time Inc. = 0.086 ms					
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1630.1	0.00	28.27	15.11	0.688	58.03
2	-14.6	1638.0	-0.25	28.40	15.14	0.676	57.77
3	-29.1	1646.5	-0.50	28.55	15.17	0.661	57.35
4	-43.3	1653.0	-0.75	28.66	15.15	0.643	56.77
5	-57.3	1665.4	-0.99	28.88	15.14	0.623	55.95
6	-70.1	1674.3	-1.22	29.03	15.06	0.602	54.79
7	-77.4	1675.7	-1.34	29.06	14.91	0.579	53.25
8	-78.5	1674.6	-1.36	29.04	14.77	0.557	51.42
9	-76.2	1663.8	-1.32	28.85	14.56	0.534	49.34
10	-69.6	1650.4	-1.21	28.62	14.28	0.512	47.03
11	-58.5	1630.3	-1.01	28.27	14.02	0.489	44.51
12	-42.9	1603.0	-0.74	27.80	13.70	0.467	41.87
13	-22.8	1574.0	-0.39	27.29	13.31	0.445	39.17
14	0.0	1535.7	0.00	26.63	12.95	0.425	36.42
15	0.0	1491.3	0.00	25.86	12.61	0.405	33.66
16	0.0	1419.4	0.00	24.61	12.66	0.387	30.87
17	0.0	1287.7	0.00	22.33	13.64	0.370	28.06
18	0.0	1075.2	0.00	18.64	14.09	0.353	25.27
19	0.0	1118.0	0.00	19.39	13.05	0.338	23.69

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 9.23 9.15

Max. Combustion Pressure 1590.0 psi

No	Rut= 1200.0, Rtoe = 720.0	kips, Time Inc. = 0.080 ms					
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1668.2	0.00	28.93	15.46	0.678	59.53
2	-17.3	1676.2	-0.30	29.07	15.50	0.664	59.21
3	-34.4	1685.8	-0.60	29.23	15.52	0.648	58.72
4	-51.3	1693.8	-0.89	29.37	15.53	0.629	58.05
5	-67.7	1706.7	-1.17	29.59	15.49	0.607	57.15
6	-81.4	1716.2	-1.41	29.76	15.40	0.585	55.86
7	-90.0	1718.8	-1.56	29.80	15.26	0.562	54.18
8	-93.4	1715.9	-1.62	29.75	15.06	0.539	52.19
9	-91.5	1702.7	-1.59	29.52	14.82	0.516	49.91
10	-84.2	1688.0	-1.46	29.27	14.53	0.492	47.35
11	-71.6	1663.3	-1.24	28.84	14.19	0.468	44.54
12	-53.7	1633.6	-0.93	28.33	13.81	0.443	41.51
13	-30.6	1598.5	-0.53	27.72	13.39	0.418	38.35
14	-2.3	1554.5	-0.04	26.96	12.94	0.394	35.13
15	0.0	1505.5	0.00	26.11	12.52	0.370	31.95
16	0.0	1429.2	0.00	24.78	12.45	0.348	28.81
17	0.0	1291.3	0.00	22.39	13.22	0.328	25.74
18	0.0	1098.2	0.00	19.04	13.49	0.308	22.78
19	0.0	1167.5	0.00	20.24	12.39	0.291	21.07

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 9.53 9.45

Max. Combustion Pressure 1590.0 psi

No	Rut= 1400.0, Rtoe= 840.0	kips, Time Inc. = 0.073 ms					
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1692.9	0.00	29.35	15.68	0.662	60.03
2	-20.8	1701.1	-0.36	29.50	15.70	0.647	59.63
3	-41.2	1710.3	-0.71	29.66	15.74	0.629	59.06
4	-61.0	1718.8	-1.06	29.80	15.74	0.609	58.32
5	-80.4	1732.3	-1.39	30.04	15.67	0.587	57.32
6	-96.3	1744.1	-1.67	30.24	15.59	0.564	55.93
7	-106.4	1747.3	-1.85	30.30	15.42	0.540	54.12
8	-110.5	1742.0	-1.92	30.21	15.19	0.517	51.97
9	-108.4	1728.4	-1.88	29.97	14.89	0.493	49.48
10	-102.1	1706.8	-1.77	29.60	14.56	0.468	46.65
11	-89.3	1679.5	-1.55	29.12	14.17	0.442	43.52
12	-70.3	1645.3	-1.22	28.53	13.71	0.416	40.18
13	-45.2	1603.9	-0.78	27.81	13.23	0.389	36.70
14	-12.7	1555.3	-0.22	26.97	12.71	0.363	33.18
15	0.0	1496.5	0.00	25.95	12.20	0.337	29.70
16	0.0	1414.0	0.00	24.52	11.99	0.313	26.28
17	0.0	1275.8	0.00	22.12	12.49	0.289	22.98
18	0.0	1128.1	0.00	19.56	12.64	0.267	19.84
19	0.0	1192.2	0.00	20.67	11.52	0.247	17.98

(Eq) Strokes Analyzed and Last Return (ft):  
 11.25 9.85 9.72 9.70

Max. Combustion Pressure 1590.0 psi

Flatiron, SB May Crk, PP30"x0.625", APED50, HI  
Robert Miner Dynamic Testing, Inc.

06/16/2021  
GRLWEAP Version 2010

Rut kips	B1 b/ft	Ct	Stroke down	(ft) up	Ten ksi	i	t	Comp ksi	i	t	ENTHRU kip-ft	B1 b/min	Rt
500.0	22.2	7.78	7.76	-0.49	6	30		25.58	7	3	54.8	42.3	
600.0	29.9	8.06	8.13	-0.78	9	28		26.32	7	3	54.1	41.4	
723.0	39.7	8.48	8.48	-0.88	8	26		27.33	7	3	54.6	40.5	
782.0	45.0	8.64	8.62	-0.85	8	49		27.69	7	3	54.8	40.2	
787.0	45.4	8.65	8.62	-0.86	8	49		27.71	8	3	54.9	40.2	
838.0	50.7	8.78	8.74	-0.93	8	48		28.01	7	3	55.6	39.9	
900.0	58.3	8.92	8.87	-1.05	8	46		28.36	7	3	56.4	39.6	
1040.0	81.2	9.23	9.15	-1.36	8	22		29.06	7	3	58.0	39.0	
1200.0	119.2	9.53	9.45	-1.62	8	42		29.80	7	3	59.5	38.4	
1400.0	211.2	9.72	9.70	-1.92	8	41		30.30	7	3	60.0	37.9	

Input File: G:\SHARED DRIVES\PJ\FLATIRON, MAY CREEK\FLATIRON,SB MAY  
 CRK,PP30X0.625, D62, HI.GWW  
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW  
 Hammer File Version: 2003 (12/4/2018)

Input File Contents

Flatiron,SB MayCrk,PP30"x0.625",PCD62,HI

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEX
6	0	857	0	1	0	0	0	0	0	40	0	0	0	0	0	0	0	0.000
Pile g Hammer g Toe Area Pile Size									Pile Type									
32.170		32.170		57.670		30.000												Pipe
W Cp		A Cp		E Cp		T Cp		CoR		ROut		StCp						
3.800		415.000		470.0		3.500		0.800		0.010		0.0						
A Cu		E Cu		T Cu		CoR		ROut		StCu								
0.000		0.0		0.000		0.000		0.000		0.0								
LPle		APle		EPle		WPle		Peri		CI		CoR		ROut				
62.000		57.67		30000.0		492.000		7.854		0		0.850		0.010				
FFatigue		F0		0-Bottom														
0		0.000		0.000														
Manufac	Hmr	Name	HmrType	No	Seg-s													
PILECO		D62-22				1												
							5											
Ram Wt		Ram L		Ram Dia		MaxStrk		RtdStrk		Efficcy								
13.67		149.20		21.63		13.20		11.80		0.80								
IB. Wt		IB. L		IB.Dia		IB CoR		IB RO										
2.83		32.36		21.63		0.900		0.010										
CompStrk	A	Chamber	V	Chamber		C Delay		C Duratn	Exp	Coeff	VolCStart	Vol	CEnd					
22.79		368.30		677.00		0.0005		0.0005		1.250		0.00		0.00				
P atm		P1		P2		P3		P4		P5								
14.70		1450.00		1305.00		1175.00		1055.00		0.00								
Stroke		Effic.	Pressure	R-Weight		T-Delay		Exp-Coeff		Eps-Str		Total-AW						
11.8000		0.8400		1450.0000		0.0000		0.0000		0.0000		0.0100		0.0000				
Qs		Qt		Js		Jt		Qx		Jx		Rati		Dept				
0.100		0.250		0.100		0.150		0.000		0.000		0.000		0.000				
Research	Soil Model:	Atoe, Plug, Gap, Q-fac																
0.000		0.000		0.000		0.000												
Research	Soil Model:	RD-skn: m, d, toe: m, d																
0.000		0.000		0.000		0.000												
Research	Toe Plug:	Res-int, Q-int, D-int, Res-plug, Q-plug, D-plug																
0.000		0.000		0.000		0.000		0.000		0.000								
Research	Toe Plug:	RD plug toe: m, d																
0.000		0.000																
Research	Toe Plug:	New Toe Plug Model is NOT applied																
Res.	Distribution																	
Dpth	Rskn	Dpth	Dpth															
0.00	0.00	49.00	49.00	0.00		0.00		0.00		0.00		0.00		0.000				
49.00	1.00	0.00	0.00	0.00		0.00		0.00		0.00		0.00		0.000				
62.00	1.00	0.00	0.00	0.00		0.00		0.00		0.00		0.00		0.000				
Rult																		
500.0	600.0	723.0	782.0	787.0		838.0		900.0		1200.0		1400.0		1600.0				

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS  
 Version 2010  
 English Units

Flatiron, SB MayCrk, PP30"x0.625", PCD62, HI

Hammer Model: D62-22      Made by: PILECO

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.734				
2	2.734	357110.0	1.000	0.0000	
3	2.734	357110.0	1.000	0.0000	
4	2.734	357110.0	1.000	0.0000	
5	2.734	357110.0	1.000	0.0000	
Imp Block	2.830	171321.0	0.900	0.0100	
Helmet	3.800	55728.6	0.800	0.0100	16.7
Combined Pile Top		44182.6			

HAMMER OPTIONS:

Hammer File ID No.	857	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	13.67	Ram Length	(inch)	149.20
Maximum Stroke	(ft)	13.20			
Rated Stroke	(ft)	11.80	Efficiency		0.840
Maximum Pressure	(psi)	1450.00	Actual Pressure	(psi)	1450.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	21.63			
Combustion Delay	(s)	0.00050	Ignition Duration	(s)	0.00050

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION

Cross Sect. Area	(in <sup>2</sup> )	415.00	PILE CUSHION		
Elastic-Modulus	(ksi)	470.0	Cross Sect. Area	(in <sup>2</sup> )	0.00
Thickness	(inch)	3.50	Elastic-Modulus	(ksi)	0.0
Coeff of Restitution		0.8	Thickness	(inch)	0.00
RoundOut	(ft)	0.0	Coeff of Restitution		0.0
Stiffness	(kips/in)	55728.6	RoundOut	(ft)	0.0
			Stiffness	(kips/in)	0.0

**PILE PROFILE:**

Toe Area	(in2)	57.670	Pile Type	Pipe
Pile Size	(inch)	30.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	57.67	30000.	492.0	7.9	0	16807.	102.9
62.0	57.67	30000.	492.0	7.9	0	16807.	102.9

Wave Travel Time 2L/c (ms) 7.378

No.	Weight	Pile and Soil Model				Soil-S	Soil-D	Quake	Total Capacity (kips)	Rut (in)	500.0
		Stiffn	C-Slk	T-Slk	CoR						
		kips	k/in	ft	ft	ft	ft	ft	ft	ft	in2
1	0.643	44183	0.010	0.000	0.85	0.0	0.100	0.100	3.26	7.9	57.7
2	0.643	44183	0.000	0.000	1.00	0.0	0.100	0.100	6.53	7.9	57.7
5	0.643	44183	0.000	0.000	1.00	0.9	0.100	0.100	16.32	7.9	57.7
6	0.643	44183	0.000	0.000	1.00	2.7	0.100	0.100	19.58	7.9	57.7
7	0.643	44183	0.000	0.000	1.00	4.5	0.100	0.100	22.84	7.9	57.7
8	0.643	44183	0.000	0.000	1.00	6.2	0.100	0.100	26.11	7.9	57.7
9	0.643	44183	0.000	0.000	1.00	8.0	0.100	0.100	29.37	7.9	57.7
10	0.643	44183	0.000	0.000	1.00	9.8	0.100	0.100	32.63	7.9	57.7
11	0.643	44183	0.000	0.000	1.00	11.6	0.100	0.100	35.89	7.9	57.7
12	0.643	44183	0.000	0.000	1.00	13.3	0.100	0.100	39.16	7.9	57.7
13	0.643	44183	0.000	0.000	1.00	15.1	0.100	0.100	42.42	7.9	57.7
14	0.643	44183	0.000	0.000	1.00	16.9	0.100	0.100	45.68	7.9	57.7
15	0.643	44183	0.000	0.000	1.00	18.7	0.100	0.100	48.95	7.9	57.7
16	0.643	44183	0.000	0.000	1.00	20.4	0.100	0.100	52.21	7.9	57.7
17	0.643	44183	0.000	0.000	1.00	22.2	0.100	0.100	55.47	7.9	57.7
18	0.643	44183	0.000	0.000	1.00	24.0	0.100	0.100	58.74	7.9	57.7
19	0.643	44183	0.000	0.000	1.00	25.8	0.100	0.100	62.00	7.9	57.7
Toe						300.0	0.150	0.250			

12.216 kips total unreduced pile weight (g= 32.17 ft/s<sup>2</sup>)  
 12.216 kips total reduced pile weight (g= 32.17 ft/s<sup>2</sup>)

**PILE, SOIL, ANALYSIS OPTIONS:**

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	49.00	Pile Damping Fact. (k/ft/s)	2.059
% Shaft Resistance	40		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170	32.170
Output Segment Generation:	Automatic		

No	Rut=	500.0,	Rtoe =	300.0	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1832.6	0.00	31.78	17.04	1.043	71.57
2	0.0	1845.3	0.00	32.00	17.07	1.033	71.38
3	0.0	1847.2	0.00	32.03	17.05	1.022	71.16
4	0.0	1857.3	0.00	32.21	17.08	1.013	71.00
5	0.0	1861.9	0.00	32.29	17.02	1.006	70.86
6	0.0	1860.8	0.00	32.27	16.95	0.999	70.52
7	0.0	1865.1	0.00	32.34	16.89	0.991	69.92
8	0.0	1859.4	0.00	32.24	16.76	0.982	69.07
9	0.0	1849.1	0.00	32.06	16.62	0.973	67.97
10	0.0	1842.3	0.00	31.95	16.51	0.964	66.64
11	0.0	1827.1	0.00	31.68	16.34	0.955	65.11
12	0.0	1806.7	0.00	31.33	16.12	0.947	63.35
13	0.0	1790.6	0.00	31.05	15.97	0.938	61.37
14	0.0	1766.9	0.00	30.64	15.77	0.930	59.16
15	0.0	1734.5	0.00	30.08	15.56	0.922	56.74
16	0.0	1689.6	0.00	29.30	15.79	0.915	54.11
17	0.0	1579.2	0.00	27.38	17.41	0.907	51.22
18	0.0	1339.7	0.00	23.23	19.81	0.900	48.07
19	0.0	1007.6	0.00	17.47	20.18	0.893	46.38

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 8.28 8.37 8.37

Max. Combustion Pressure 1450.0 psi

No	Rut=	600.0,	Rtoe=	360.0	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1915.0	0.00	33.21	17.79	0.925	71.92
2	0.0	1930.5	0.00	33.48	17.89	0.913	71.65
3	0.0	1938.9	0.00	33.62	17.87	0.901	71.37
4	0.0	1940.5	0.00	33.65	17.87	0.888	71.08
5	0.0	1951.2	0.00	33.83	17.84	0.876	70.72
6	0.0	1951.7	0.00	33.84	17.72	0.863	70.15
7	0.0	1951.0	0.00	33.83	17.64	0.851	69.33
8	0.0	1948.9	0.00	33.79	17.53	0.838	68.24
9	0.0	1936.3	0.00	33.58	17.34	0.824	66.90
10	0.0	1924.8	0.00	33.38	17.17	0.810	65.31
11	0.0	1910.5	0.00	33.13	16.99	0.800	63.61
12	0.0	1887.0	0.00	32.72	16.75	0.789	61.72
13	0.0	1863.7	0.00	32.32	16.48	0.779	59.62
14	0.0	1838.7	0.00	31.88	16.26	0.769	57.29
15	0.0	1803.9	0.00	31.28	16.02	0.759	54.76
16	0.0	1749.8	0.00	30.34	16.15	0.750	52.02
17	0.0	1635.8	0.00	28.36	17.64	0.740	49.06
18	0.0	1385.5	0.00	24.02	19.77	0.732	45.86
19	0.0	1089.1	0.00	18.89	19.60	0.723	44.14

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 8.90 8.87

Max. Combustion Pressure 1450.0 psi

No	Rut=	723.0,	Rtoe =	433.8	kips, Time Inc.	=0.088 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1981.1	0.00	34.35	18.44	0.834	71.88
2	0.0	1997.5	0.00	34.64	18.48	0.819	71.46
3	0.0	1999.9	0.00	34.68	18.46	0.804	71.04
4	0.0	2011.6	0.00	34.88	18.49	0.789	70.62
5	-1.7	2017.3	-0.03	34.98	18.41	0.774	70.11
6	-3.6	2017.7	-0.06	34.99	18.31	0.759	69.39
7	-2.8	2021.6	-0.05	35.06	18.22	0.744	68.37
8	0.0	2013.0	0.00	34.91	18.03	0.729	67.09
9	0.0	2001.5	0.00	34.71	17.84	0.714	65.56
10	0.0	1989.6	0.00	34.50	17.65	0.699	63.78
11	0.0	1966.9	0.00	34.11	17.38	0.684	61.77
12	0.0	1942.5	0.00	33.68	17.07	0.668	59.53
13	0.0	1917.2	0.00	33.24	16.81	0.653	57.10
14	0.0	1882.2	0.00	32.64	16.49	0.640	54.56
15	0.0	1842.3	0.00	31.94	16.14	0.628	51.87
16	0.0	1787.2	0.00	30.99	16.22	0.615	48.98
17	0.0	1659.7	0.00	28.78	17.53	0.603	45.91
18	0.0	1410.7	0.00	24.46	19.30	0.592	42.67
19	0.0	1180.9	0.00	20.48	18.66	0.582	40.92

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 9.44 9.33 9.32

Max. Combustion Pressure 1450.0 psi

No	Rut=	782.0,	Rtoe=	469.2	kips, Time Inc.	=0.088 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	2008.1	0.00	34.82	18.69	0.804	72.03
2	-2.3	2025.1	-0.04	35.12	18.74	0.788	71.52
3	-6.7	2027.5	-0.12	35.16	18.71	0.771	71.00
4	-11.0	2039.7	-0.19	35.37	18.75	0.755	70.47
5	-15.3	2045.5	-0.26	35.47	18.66	0.738	69.87
6	-18.0	2046.5	-0.31	35.49	18.56	0.722	69.04
7	-17.6	2050.2	-0.31	35.55	18.46	0.705	67.92
8	-14.2	2040.6	-0.25	35.38	18.25	0.689	66.52
9	-7.8	2028.9	-0.13	35.18	18.04	0.673	64.87
10	0.0	2015.5	0.00	34.95	17.84	0.657	62.98
11	0.0	1990.7	0.00	34.52	17.54	0.642	60.87
12	0.0	1965.3	0.00	34.08	17.21	0.627	58.54
13	0.0	1937.3	0.00	33.59	16.92	0.612	56.05
14	0.0	1899.4	0.00	32.94	16.56	0.598	53.42
15	0.0	1857.8	0.00	32.21	16.18	0.584	50.62
16	0.0	1799.5	0.00	31.20	16.22	0.571	47.67
17	0.0	1669.3	0.00	28.95	17.46	0.558	44.55
18	0.0	1418.4	0.00	24.59	19.05	0.546	41.27
19	0.0	1224.2	0.00	21.23	18.25	0.535	39.48

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 9.64 9.51 9.50

Max. Combustion Pressure 1450.0 psi

No	Rut=	787.0,	Rtoe =	472.2	kips, Time Inc.	=0.088 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	2014.8	0.00	34.94	18.72	0.802	72.10
2	-2.7	2020.6	-0.05	35.04	18.74	0.786	71.57
3	-7.1	2036.8	-0.12	35.32	18.79	0.769	71.04
4	-11.4	2041.4	-0.20	35.40	18.72	0.752	70.51
5	-15.5	2046.7	-0.27	35.49	18.70	0.735	69.90
6	-18.0	2054.8	-0.31	35.63	18.62	0.719	69.06
7	-17.5	2048.8	-0.30	35.53	18.43	0.703	67.93
8	-14.1	2045.3	-0.24	35.47	18.29	0.687	66.53
9	-7.6	2035.2	-0.13	35.29	18.10	0.671	64.87
10	0.0	2013.2	0.00	34.91	17.82	0.656	62.97
11	0.0	1996.1	0.00	34.61	17.56	0.640	60.87
12	0.0	1970.8	0.00	34.17	17.28	0.624	58.56
13	0.0	1935.3	0.00	33.56	16.92	0.610	56.08
14	0.0	1903.8	0.00	33.01	16.55	0.595	53.42
15	0.0	1863.4	0.00	32.31	16.25	0.581	50.62
16	0.0	1801.6	0.00	31.24	16.21	0.568	47.66
17	0.0	1675.1	0.00	29.05	17.48	0.555	44.53
18	0.0	1417.3	0.00	24.58	19.04	0.543	41.23
19	0.0	1231.4	0.00	21.35	18.23	0.532	39.44

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 9.65 9.52 9.51

Max. Combustion Pressure 1450.0 psi

No	Rut=	838.0,	Rtoe=	502.8	kips, Time Inc.	=0.088 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	2023.2	0.00	35.08	18.82	0.784	72.01
2	-2.6	2042.9	-0.04	35.42	18.92	0.772	71.72
3	-7.1	2050.4	-0.12	35.55	18.87	0.756	71.25
4	-11.7	2055.7	-0.20	35.65	18.90	0.738	70.66
5	-16.1	2066.2	-0.28	35.83	18.84	0.721	69.98
6	-18.8	2064.9	-0.33	35.81	18.67	0.703	69.07
7	-18.1	2068.2	-0.31	35.86	18.59	0.686	67.85
8	-14.2	2061.8	-0.25	35.75	18.41	0.668	66.36
9	-7.1	2043.0	-0.12	35.43	18.13	0.651	64.60
10	0.0	2031.7	0.00	35.23	17.93	0.634	62.59
11	0.0	2008.5	0.00	34.83	17.64	0.617	60.35
12	0.0	1975.8	0.00	34.26	17.28	0.600	57.91
13	0.0	1948.5	0.00	33.79	16.94	0.584	55.30
14	0.0	1910.8	0.00	33.13	16.57	0.568	52.53
15	0.0	1862.4	0.00	32.29	16.19	0.553	49.62
16	0.0	1801.6	0.00	31.24	16.16	0.539	46.58
17	0.0	1670.1	0.00	28.96	17.34	0.525	43.39
18	0.0	1420.6	0.00	24.63	18.70	0.512	40.05
19	0.0	1260.9	0.00	21.86	17.81	0.500	38.23

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 9.77 9.63 9.62

Max. Combustion Pressure 1450.0 psi

No	Rut= 900.0, Rtoe = 540.0	kips	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	Time ms	Inc. =0.088	max Et kip-ft
1	0.0	2053.2	0.00	35.60	19.08	0.777					73.11
2	-4.3	2063.2	-0.08	35.78	19.05	0.764					72.79
3	-9.2	2074.4	-0.16	35.97	19.14	0.748					72.29
4	-14.3	2082.8	-0.25	36.12	19.10	0.729					71.64
5	-19.3	2083.5	-0.34	36.13	19.02	0.709					70.80
6	-22.5	2095.2	-0.39	36.33	18.95	0.689					69.67
7	-22.1	2091.7	-0.38	36.27	18.77	0.669					68.27
8	-18.2	2082.6	-0.31	36.11	18.56	0.650					66.57
9	-10.8	2073.2	-0.19	35.95	18.36	0.631					64.62
10	-0.2	2051.0	0.00	35.56	18.06	0.612					62.43
11	0.0	2026.9	0.00	35.15	17.72	0.593					60.02
12	0.0	2000.0	0.00	34.68	17.41	0.575					57.41
13	0.0	1962.1	0.00	34.02	17.02	0.557					54.62
14	0.0	1922.5	0.00	33.34	16.56	0.540					51.70
15	0.0	1878.5	0.00	32.57	16.20	0.524					48.65
16	0.0	1811.8	0.00	31.42	16.09	0.508					45.50
17	0.0	1678.9	0.00	29.11	17.19	0.493					42.22
18	0.0	1420.8	0.00	24.64	18.48	0.479					38.83
19	0.0	1301.6	0.00	22.57	17.32	0.466					36.96

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 9.92 9.78 9.77

Max. Combustion Pressure 1450.0 psi

No	Rut= 1200.0, Rtoe= 720.0	kips	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	Time ms	Inc. =0.080	max Et kip-ft
1	0.0	2138.3	0.00	37.08	19.84	0.748					76.68
2	-13.4	2152.4	-0.23	37.32	19.94	0.732					76.24
3	-25.5	2161.9	-0.44	37.49	19.93	0.715					75.64
4	-36.6	2174.8	-0.63	37.71	19.94	0.695					74.92
5	-46.6	2180.7	-0.81	37.81	19.88	0.674					73.97
6	-53.1	2188.8	-0.92	37.95	19.69	0.652					72.57
7	-54.1	2189.1	-0.94	37.96	19.55	0.628					70.62
8	-49.8	2173.1	-0.86	37.68	19.24	0.602					68.16
9	-40.9	2161.9	-0.71	37.49	18.97	0.576					65.29
10	-27.2	2134.8	-0.47	37.02	18.57	0.549					62.07
11	-8.9	2103.0	-0.16	36.47	18.17	0.522					58.58
12	0.0	2065.2	0.00	35.81	17.69	0.495					54.85
13	0.0	2015.3	0.00	34.95	17.17	0.469					50.98
14	0.0	1967.7	0.00	34.12	16.61	0.444					47.16
15	0.0	1904.0	0.00	33.02	16.05	0.421					43.39
16	0.0	1828.4	0.00	31.70	15.75	0.399					39.66
17	0.0	1686.2	0.00	29.24	16.43	0.379					35.95
18	0.0	1437.5	0.00	24.93	17.06	0.360					32.30
19	0.0	1438.3	0.00	24.94	15.42	0.342					30.24

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 10.52 10.36 10.35

Max. Combustion Pressure 1450.0 psi

No	Rut= 1400.0, Rtoe = 840.0	kips	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	Time ms	Inc. =0.073	max Et kip-ft
1	0.0	2188.8	0.00	37.95	20.33	0.734					78.71
2	-9.8	2206.0	-0.17	38.25	20.42	0.718					78.21
3	-18.4	2217.3	-0.32	38.45	20.47	0.699					77.57
4	-26.3	2225.0	-0.46	38.58	20.46	0.679					76.81
5	-33.6	2235.0	-0.58	38.76	20.37	0.658					75.80
6	-38.1	2245.8	-0.66	38.94	20.19	0.635					74.26
7	-37.1	2246.0	-0.64	38.95	19.96	0.610					72.10
8	-30.6	2235.8	-0.53	38.77	19.69	0.584					69.38
9	-18.7	2215.4	-0.32	38.42	19.33	0.557					66.21
10	-1.3	2185.1	-0.02	37.89	18.89	0.529					62.66
11	0.0	2145.4	0.00	37.20	18.36	0.501					58.79
12	0.0	2099.4	0.00	36.40	17.83	0.473					54.62
13	0.0	2048.6	0.00	35.52	17.24	0.444					50.24
14	0.0	1989.3	0.00	34.49	16.58	0.414					45.75
15	0.0	1920.4	0.00	33.30	15.89	0.386					41.23
16	0.0	1829.0	0.00	31.72	15.45	0.359					36.88
17	0.0	1682.8	0.00	29.18	15.90	0.334					32.71
18	0.0	1441.0	0.00	24.99	16.21	0.311					28.78
19	0.0	1495.3	0.00	25.93	14.38	0.290					26.53

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 10.89 10.71 10.68

Max. Combustion Pressure 1450.0 psi

No	Rut= 1600.0, Rtoe= 960.0	kips	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	Time ms	Inc. =0.067	max Et kip-ft
1	0.0	2239.8	0.00	38.84	20.88	0.728					81.30
2	0.0	2259.4	0.00	39.18	20.97	0.710					80.71
3	0.0	2275.9	0.00	39.46	21.00	0.691					80.02
4	-1.3	2288.1	-0.02	39.68	20.98	0.670					79.22
5	-4.9	2301.2	-0.08	39.90	20.88	0.648					78.13
6	-5.2	2309.9	-0.09	40.05	20.71	0.624					76.44
7	0.0	2306.6	0.00	40.00	20.47	0.598					74.06
8	0.0	2291.9	0.00	39.74	20.13	0.571					71.07
9	0.0	2268.5	0.00	39.34	19.72	0.543					67.58
10	0.0	2236.9	0.00	38.79	19.22	0.515					63.68
11	0.0	2194.8	0.00	38.06	18.66	0.486					59.41
12	0.0	2143.1	0.00	37.16	18.02	0.456					54.80
13	0.0	2082.4	0.00	36.11	17.32	0.425					49.94
14	0.0	2013.5	0.00	34.91	16.57	0.394					44.99
15	0.0	1935.3	0.00	33.56	15.81	0.364					40.05
16	0.0	1838.5	0.00	31.88	15.24	0.334					35.24
17	0.0	1682.5	0.00	29.17	15.42	0.306					30.65
18	0.0	1445.9	0.00	25.07	15.50	0.279					26.36
19	0.0	1542.1	0.00	26.74	13.57	0.255					23.84

(Eq) Strokes Analyzed and Last Return (ft):  
 11.80 11.11 11.02

Max. Combustion Pressure 1450.0 psi

Flatiron, SB MayCrk, PP30"x0.625", PCD62, HI  
Robert Miner Dynamic Testing, Inc.

06/16/2021  
GRLWEAP Version 2010

Rut kips	B1 b/ft	Ct	Stroke down	(ft) up	Ten ksi	i	t	Comp ksi	i	t	ENTHRU kip-ft	B1 b/min	Rt
500.0	17.1	8.37	8.37	0.00	1	0	32.34	7	3	71.6	40.6		
600.0	22.5	8.90	8.87	0.00	1	0	33.84	6	3	71.9	39.5		
723.0	30.6	9.33	9.32	-0.06	6	50	35.06	7	3	71.9	38.5		
782.0	34.8	9.51	9.50	-0.31	6	50	35.55	7	3	72.0	38.2		
787.0	35.1	9.52	9.51	-0.31	6	50	35.63	6	3	72.1	38.2		
838.0	38.7	9.63	9.62	-0.33	6	48	35.86	7	3	72.0	38.0		
900.0	43.5	9.78	9.77	-0.39	6	47	36.33	6	3	73.1	37.7		
1200.0	78.9	10.36	10.35	-0.94	7	40	37.96	7	3	76.7	36.7		
1400.0	120.0	10.71	10.68	-0.66	6	39	38.95	7	3	78.7	36.1		
1600.0	183.9	11.11	11.02	-0.09	6	41	40.05	6	3	81.3	35.5		